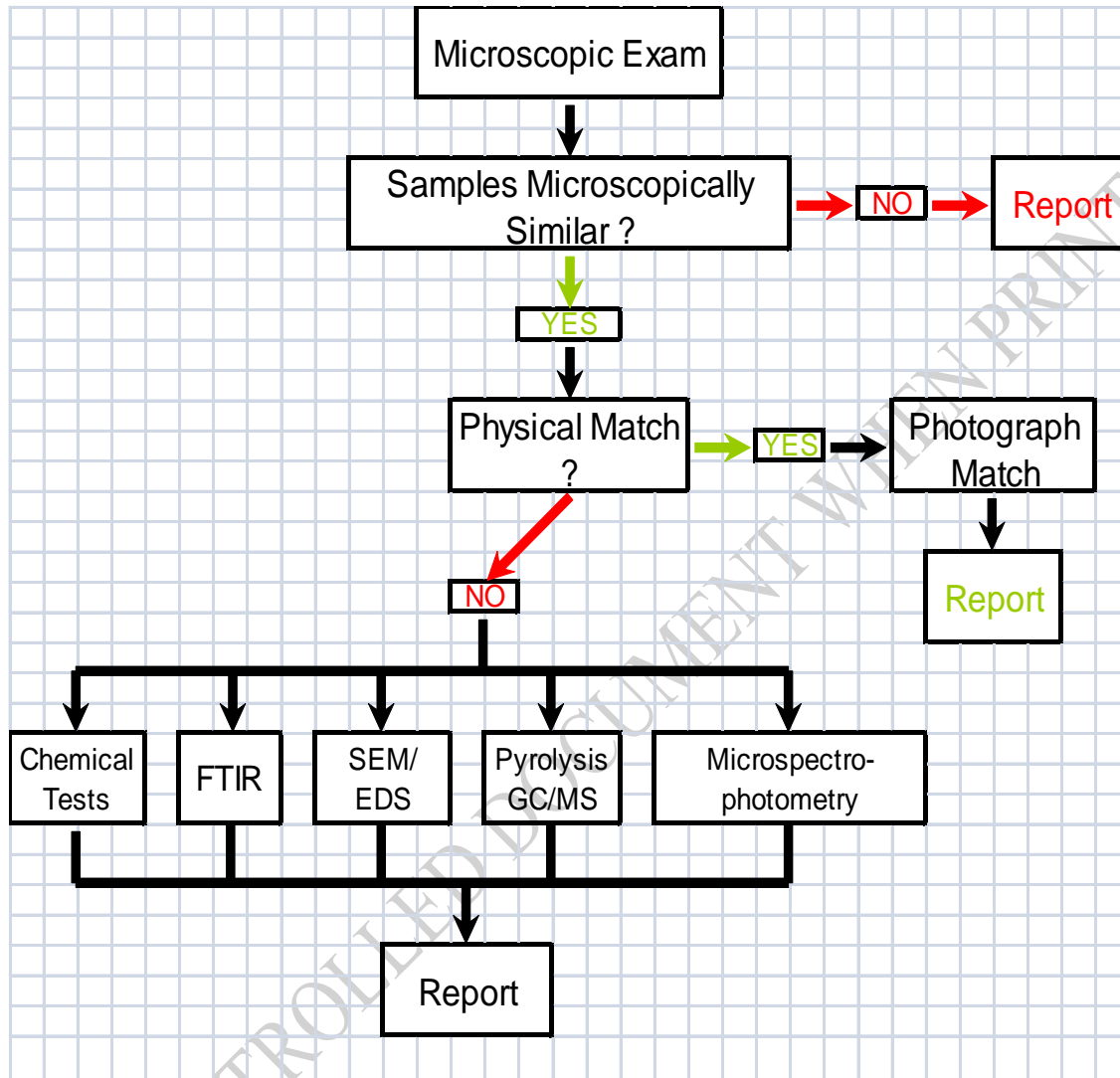


General flow diagram for the examination of paint samples:



I. Name of Analytical Procedure

Paint analysis.

II. Suggested Applications

Procedure for the examination of paint evidence.

III. Analytical Procedures

A. Screening, searching, and retrieval of evidence

1. Before any screening, searching, or retrieval of evidence is performed, the analyst should try to get as many facts as possible about the case.
2. Note the condition of the items submitted. Also note any items found that were not listed on the package or submission forms (i.e. items found in pockets)
3. During the visual examination of the evidence, remove any obvious paint chips that may be adhering to the surface of the item.
4. If smears are present, then:
 - a. take a cutting of the smear if it is on clothing
 - b. remove a sample of the smear if it is on an object
5. Additionally, clothing should be scraped over clean paper. All items of clothing should be processed on the inside surface as well as the outside surface (this includes the pocket areas).
6. After an item of evidence has been scraped / examined and placed back into its original container, the debris remaining on the clean paper should be collected and examined under the stereomicroscope for the presence of any paint chips.
7. All collected samples should be packaged so as to prevent loss and contamination.

B. Physical Match

1. The edges (or striae) of the samples are visually examined macroscopically and, if appropriate, microscopically for a physical fit.
2. Photograph the results if possible.
3. If a physical match is made, no further analysis is required.

C. Visual examination

1. Describe the physical characteristics, such as color, size, layer structure, texture.
2. Describe any additional characteristics noted.

D. Chemical tests - The analyst may perform any of the following tests when appropriate.

1. Observe the reaction of the sample (ie dissolving, swelling, curling, etc) when subjected to chloroform and acetone.
 - a. Acrylic lacquers - soluble in both

- b. Nitrocellulose lacquers
 - (1) soluble in acetone
 - (2) insoluble in chloroform
- c. Enamels - insoluble in both.
- 2. Diphenylamine
 - a. Reagent preparation - combine 1g diphenylamine, 40ml water, and 200ml conc. sulfuric acid. This reagent will expire one year from the date of preparation.
 - b. Before each use, the reagent must be tested with a known nitrate or nitrocellulose paint. The solution turns blue in the presence of the known nitrate or nitrocellulose paint. This is considered a positive QC check.
 - c. Reaction
 - (1) If it turns blue, the paint contains nitrocellulose.
 - (2) Other reactions should be recorded as well (i.e. bubbling, dissolving).
- 3. Reactions to other reagents / solvents may be observed as needed.

E. Instrumental methods of analysis

- 1. Micro-Fourier Transform Infrared Spectroscopy (FTIR)
 - a. Used to compare and/or identify paint binders and some inorganic components.
 - b. Preparation for analysis.
 - (1) Thin section the sample, either by hand or by using a microtome.
 - (2) Flatten samples
 - (3) Place samples onto a KBr disk
 - (4) Place the KBr disk onto the FTIR microscope and collect data according to the instrumental procedures for the instrument.
- 2. Pyrolysis - Gas Chromatography / Mass Spectrometry (py-GC/MS)
 - a. Usage
 - (1) Another method to compare and identify the organic components of the paint sample.
 - (2) The questioned sample must have the same layer structure as the known (partial layer structure cannot be compared to full layer structure)
 - (3) Not appropriate for:
 - (a) Contaminated samples
 - (b) Samples present in insufficient quantity for analysis.
 - b. Sample preparation
 - (1) Place sample into clean container
 - (2) Submit to instrument operator for analysis.
- 3. Scanning Electron Microscopy/Energy Dispersive Spectroscopy (SEM/EDS)
 - a. Used for the detection of inorganic extenders and/or hiding pigments.
 - b. Sample preparation
 - (1) Clean, single layer paint films may not require any preparation
 - (2) If more than one layer is present, peel or cross section as

- appropriate.
- (3) Place the sample onto an SEM adhesive stub and submit to an SEM Operator for analysis.
4. Microspectrophotometry
- a. Used to compare the color of visually similar paint samples.
- b. Methods
- (1) Diffuse reflectance
- (a) Clean the surface of the paint.
- (b) Collect data according to the instrumental procedures for the instrument.
- (2) Transmission
- (a) Thin section the sample either by hand or microtome.
- (b) The samples must be of the same thickness for optimal results.
- (c) Collect data according to the instrumental procedures for the instrument.
- F. Vehicle Make / Model Search
1. If full layer paint chips are found during the screening process and there is no suspect vehicle, the case may be suitable for make/model determination.
2. The layers of the paint chip are separated and characterized by FTIR and SEM/EDS.
3. The resulting chemical information is entered into the database and a search performed.
4. Additional information regarding the color of the chip can be found using the manufacturer repaint books.
5. If a list of potential vehicles is generated using the paint database (PDQ), a report is then written with the generated information regarding make, model, plant of manufacture, year of manufacture, color code, and possible VIN information.

IV. Possible conclusions of analytical results

- A. Paint from Item A is consistent with paint from Item B, therefore the paint from Item A could have originated from Item B or the paint from Items A and B could have shared a common origin/originated from the same source.

This statement is used when the questioned and known samples are consistent in color, layer structure, and chemical composition.

- B. Paint from Item A is not consistent with / is different than paint from Item B. Therefore, the paint from Items A and B did not share a common origin.

This statement is associated with the comparison of paint in which one or more of the characteristics associated with the paints are different.

- C. Paint from Item A was chemically similar to the paint from Item B. However, some differences were noted.

Questioned and Known paints exhibit similarities in characteristics. However one or more differences were noted.

- D. No paint associations were found between Item A and Item B.

1. No paint of value was found for a comparison (not the appropriate color), or
2. No paint was found on the questioned item.

- E. The edge of Paint Chip A matched the edge of Paint Chip B. Therefore, at one time Paint Chip A and Paint Chip B were joined together

This statement is used in physical match cases.

- F. Inappropriate packaging of paint samples.

- G. Paint evidence returned unworked.

1. Evidence may be returned at the request of the investigating agency, DA, etc.
2. According to Trace Evidence Section policy, the paint evidence is being returned unworked pending the outcome of nuclear DNA analysis. If nuclear DNA analysis does not identify the suspect/victim, the paint evidence may be resubmitted for analysis

- H. No proper standards submitted.

- I. The item was processed to preserve paint evidence.

The paint was not analyzed at this time, however as it may be necessary to analyze it in the future, the paint evidence was collected and preserved.

- J. It is highly unlikely that paint from Item A originated from a source other than Item B.

The questioned paint is consistent with the known standard and is so complex or unusual in its physical and chemical properties that it is highly unlikely that it could have come from any other source.

- K. No paint found.

- L. Vehicle Make/Model Search

The chemical characteristics of the paint chip that were entered into the

database revealed / did not reveal information regarding vehicle make, model, plant of manufacture, and year of manufacture.

The paint chips located in the clothing were not suitable for entry into the database.

M. Inconclusive

Due to the size or condition of the questioned paint sample, no conclusions could be reached as to the origin of the paint.

These procedures have been reviewed and approved for use by the personnel of the Trace Evidence Section of the State Bureau of Investigation Crime Laboratory. This action does not signify this procedure to be mandated to the extent that it precludes the use of variations of this procedure or different procedures for accomplishing the desired assay. Physical and personnel resources, technological change, and examiner preference (within the bounds of good laboratory technique and quality control) determine what examination procedures are appropriate and / or acceptable for a given set of circumstances as encountered in the Trace Evidence Section.

References

1. Cousins DR, et al. "The Use of Microspectrophotometry for the Identification of Pigments in Small Paint Samples," Forensic Science International, 24, 1984, pp. 183-196.
2. Crown DA. The Forensic Examination of Paints and Pigments, Springfield: C.C. Thomas, 1986.
3. Heilman WR. "Nondestructive Infrared and X-Ray Diffraction Analyses of Paints and Plastics," Journal of Forensic Sciences, Vol. 5, 1960, p. 338.
4. Nowicki J, Patten R. "Examination of US Automotive Paints: I. Make and Model Determination of Hit-and-Run Vehicles by Reflectance Microspectrophotometry," Journal of Forensic Science, Vol. 31, No. 2, April 1986, pp. 464-470.
5. Nylen P, Sunderland E. Modern Surface Coatings, New York: Interscience, 1965.
6. Rodgers PG, et al. "The Classification of Automobile Paint by Diamond Window Infrared Spectroscopy, Part I: Binders and Pigments," Canadian Society of Forensic Science Journal, 9(1), 1976, pp. 1-14.
7. Ryland S. "Paint Binder Classification by Infrared Spectrometry and Pyrolysis Gas Chromatography," SAFS, Spring 1991.
8. Saferstein R, ed. Forensic Science Handbook (Chapter 10: Forensic Paint Examination), 1982, pp. 529-57.
9. Thorton JI, et al. "Solubility Characterization of Automotive Paints," Journal of Forensic Science, 28(4), 1983, pp. 1004-1007.
10. US Department of Justice, FBI. Workshop on the Forensic Analysis of Paint, Quantico, VA, December 5-9, 2005.
11. Ward DC, Carlson TL. "Paint Analysis Using the Scanning Electron Microscope," Crime Laboratory Digest, February 1983, pp. 2-6.
12. Wolf CJ, et al. "Pyrolysis Gas Chromatography of Polymers," Analytical Chemistry, 52(3), 1980, pp. 348-258.